Integrated Vehicle Health Management System,
Record Playback Subsystem Hazardous Gas Detection
System, and other Consolidated Data

Thread Assessment

Atlas Design Panel 1

84K00303-017

April 29, 1998

Version 2.0

Integrated Vehicle Health Management System, Record Playback Subsystem, Hazardous Gas Detection System, and other Consolidated Data Thread
Table of Contents

Assessment Team

Name	CI Represented	E-Mail Address	Phone
Beever, Tom	Data Retrieval		1-7337
Breznik, Greg	BUHG developer		1-3697
Griffin, Laurie	Data Bank		1-2295
Hale, Ken	User Application		1-2222
Hrezo, Gary	FD Viewers		1-9002
King, Charla	Test Build		1-7587
Le, Chau	CS Gateway		1-2293
Lee, Roger	CSDS Gateway		1-7697
Mann, Dave	RPS Rep		1-7699
Quinn, Shawn	CS Gateway		1-9065
Samson, Julia	Application Services		1-9001
Seaton, Glenn	Networks		1-7392
Stanley, Rex	Basis		1-9076
Valencia, Emilio	SE Thread Lead		1-9074

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

ii

1.   Introduction

1.1   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Overview

This thread provides process improvement to the current operations by providing increased visibility to the Integrated Vehicle Health Management System, the Record Playback System, and Hazardous Gas System. These measurements will be consolidated in to the Consolidated Systems (CS) Gateway and provide to the Shuttle Data Stream. This will make this data available in the current operational area and allow it to be used in the future by the CLCS system.

The Integrated Vehicle Health Management (IVHM) project is part of the Shuttle Upgrades program. IVHM/Human Exploration and Development (HEDS) Technology Demonstration (HTD), demonstrates off-the-shelf sensing technologies in an operational environment to make informed design decisions for the eventual Orbiter upgrade. Integrated Vehicle Health Management takes the Orbiter's instrumentation system a step further by providing capabilities to process data real-time versus merely recording data. It is planned to fly two Human Exploration and Development of Space Technology Demonstrations on the same Orbiter on successive flights with incorporation of additional sensors between flights. During cryogenic propellant load in terminal launch countdown, a Vehicle Health Monitoring data stream will be routed out of the Orbiter's T-0 umbilical for transmission, processing and viewing in the Launch Control Center. At approximately T-5 minutes, a command will be sent to the Vehicle Health Monitoring processor to begin recording data. Data will be recorded on ascent, during three planned one hour snap shot periods and on descent. The processor will be dumped to a ground system after the Orbiter has landed and has rolled into its Orbiter Processing Facility bay.

The Backup hazardous Gas Detection System consists of a set of specialized hardware and software located in each of the mobile launchers. The system provides LPS HIM's with a very minimal set of data. The system is controlled (and more detail data is displayed) via a dumb terminal located in the CCMS control rooms. There is a project to upgrade this interface with a PC-based GUI (Labview) for command and control. This interface will provide a Shuttle Data Stream Prime to provide this data to the user community.

Additional data sources will be added to the Consolidated System Gateway and for recording on Shuttle Data Center .

Highlights:

- Additional data available in the operational control rooms
    - Integrated Vehicle Health Management
    - Hazardous Gas System
- Consolidated Systems (CS) Gateway will be activated
- RPS data available in LCC-X

1.2   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Concept

This thread will provide operational support to the IVHM/HTD installed in the orbiter. The support includes the capability to monitor, command and record data from the HTD. The major system functions are the display function capability using the SL-GMS dynamic data visualization tool, data health, data distribution, commanding, data recording and CS Gateway processing.

HTD operations will be supported by CLCS from the LCC-X starting at cryo load through launch. To minimize risk, CLCS H/W and S/W supporting HTD will be put under configuration control when rollout occurs. Also, LCC-X is required to provide support for post-landing processing. Once the orbiter has been rolled into the OPF, the HTD data that was recorded in flight will be transmitted through the T-0 interface to CLCS for processing.

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

1
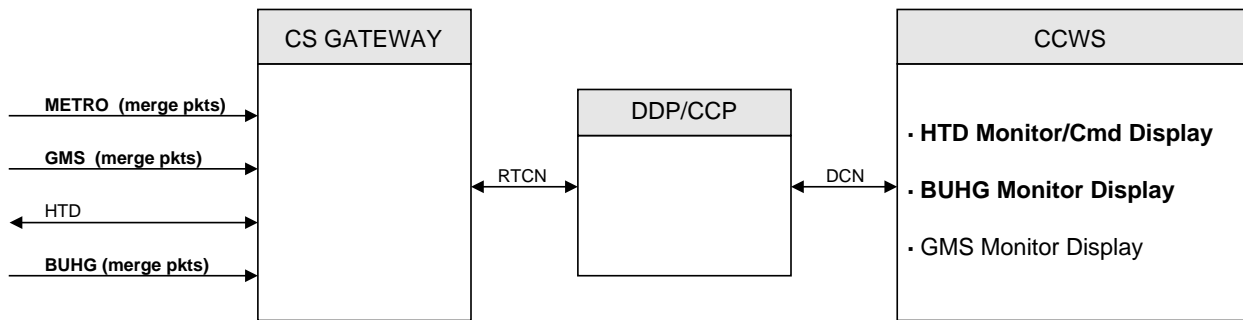
Figure 0-1 Thread Concept Diagram

This thread will provide the capability to support the following number of FDs:

- HTD -   Process approximately 400 FDs (80 are carried over from HTD 1)
- BUHG -   Process approximately 15 new FDs
- RPS -   Monitor only via an X-window interface

1.3   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Specification

1.3.1   Statement of Work

General

- Add commanding to the Consolidate System Gateway. PROVIDED AS A DELTA THOR DELIVERY

- Identify and implement command processing requirements. Add and document new C-Cs to CLCS as required. PROVIDED AS A DELTA THOR DELIVERY

- Identify and implement Metro health and status for display (Data and Link Health) and maintenance interface

- Identify and implement GMS health and status for display (Data and Link Health) and maintenance interface.

- Develop an Interface Control Document (ICD) between the Pad Meteorological System (or Consolidate Shuttle Data Stream (CSDS) Gateway and the Consolidated Systems (CS) Gateway (includes GMS and Metro data) ?) and CLCS.

- Develop an Interface Control Document (ICD) between the GMS (or Consolidate Shuttle Data Stream Gateway ?) and CLCS.

- Re-run existing CSDS Gateway regression test as required (used to Re-Validate the Shuttle Data Stream Prime data stream as required)

- Oversee installation of Consolidated Systems Gateway Hardware in SDE-1, SDE-2, IDE-1 and LCC-X.

- Build SL Display for Neural Net Prototype (display to run on Window NT)

Integrated Vehicle Health ManagementMonitoring

- Identify and implement HTD-1 and HTD-2 health and status for display (Data and Link Health)and maintenance interface

- Develop an Interface Control Document (ICD) between the HTD-1, HTD-2 and CLCS.

- Process Integrated Vehicle Health Management data for HTD 2~~Collect Integrated Vehicle Health Monitoring data. For HTD2~~

- Receive HTD~~Consolidate Integrated Vehicle Health Monitoring~~ data in the Consolidated System Gateway ~~and merge output into Shuttle Data Stream Prime.~~

- Merge HTD data into the Shuttle Data Stream Prime.

- Add Vehicle Health Monitoring to the Data Bank.

    - Define the HTD unique FDs and provide the system and application services to support them for the Vehicle Health Monitoring Technology Demonstration.
    - HTD2 has 320~~300~~ FDs

- Support HTD1 and HTD2 testing

- Provide additional CLCS monitor display(s)

- Provide CLCS command display(s)

Record Playback Subsystem

- Provide X-Window interface to Record Playback Subsystem

- ~~Identify and implement Record Playback Subsystem health and status for display and maintenance interface.~~

- ~~Develop an Interface Control Document (ICD) between the Record Playback Subsystem (or Consolidate Shuttle Data Stream Gateway ?) and CLCS.~~

- ~~Collect data from the Record Playback Subsystem~~

- ~~Provided selected Record Playback Subsystem data to the Consolidated System Gateway.~~

- ~~Consolidate Integrated Record Playback System data in the Consolidated System Gateway and merge output into Shuttle Data Stream Prime.~~

- ~~Define the Record Playback Subsystem unique FDs and provide the system and application services to support them.~~

- ~~Add Record Playback Subsystem FDs to the Data Bank~~

- ~~Build PCGOAL Display for Record Playback Subsystem~~

- ~~Build sample CLCS Display for Record Playback Subsystem~~

Backup Hazardous Gas

- Identify and implement Hazardous Gas system health and status for display (Data and Link Health)~~and maintenance interface.~~

- Develop an Interface Control Document (ICD) between the Hazardous Gas system and the~~(or~~ Consolidate Shuttle Data Stream Gateway ~~?) and CLCS~~.

- Collect data from the Hazardous Gas system

- Consolidate Integrated Backup Hazardous Gas data in the Consolidated SDS~~System~~ Gateway and merge output into Shuttle Data Stream Prime.

- Define the Hazardous Gas unique FDs and provide the system and application services to support them.

- Add Hazardous Gas FDs to the Data Bank

- Build PCGOAL Display for Hazardous Gas systems

- Build sample FD viewer~~CLCS Display~~ for Hazardous Gas systems

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

3

1.3.2 Requirements

Requirements for Buy Off from SLS

1. **ATLAS BUY OFF SLS 2.1.1.15.1** The Ground Measurement System (GMS) interface shall be via UDP/IP.

2. **ATLAS BUY OFF SLS 2.1.1.16.1** The Pad Meteorological System (Metro) interface shall be via a buffered RS-232 interface as described in:

   - KSC-DL-3768, LC-39 Pad Meteorological System LCC Computer System Theory of Operations

Requirements from SLS

- The CLCS interface to the Backup Hazardous Gas Detection System (HGDS) shall be via a ~~buffered~~ EthernetRS-232 interface.

- Orbiter Upgrades Interface The Orbiter Upgrades Project is being defined and will result in new or modified interfaces for CLCS. None of these interfaces are sufficiently mature to include in this release of this document.

1.4 IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Hardware Diagram

1.4.1 Gateway Hardware Diagram (BUHG, GMS and Metro Data)
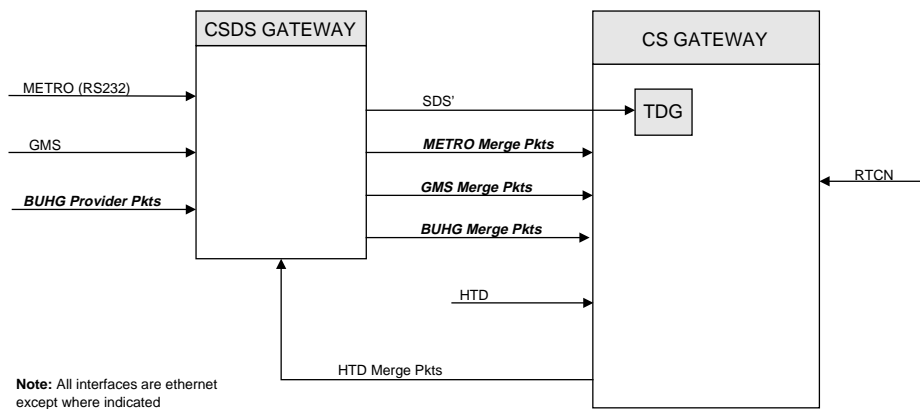
Figure 0-2 Gateway Data Flow Diagram

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

4

1.4.2 BUHG Hardware Diagram

FIRING ROOM 1

MASTER

MODEM

MODEM

B/U
HGDS

LCC 3R18 (ESA)

MODEM

Provider Packets

CSDS
Gateway

SLAVE

MODEM

MODEM

MASTER

FIRING ROOM 3
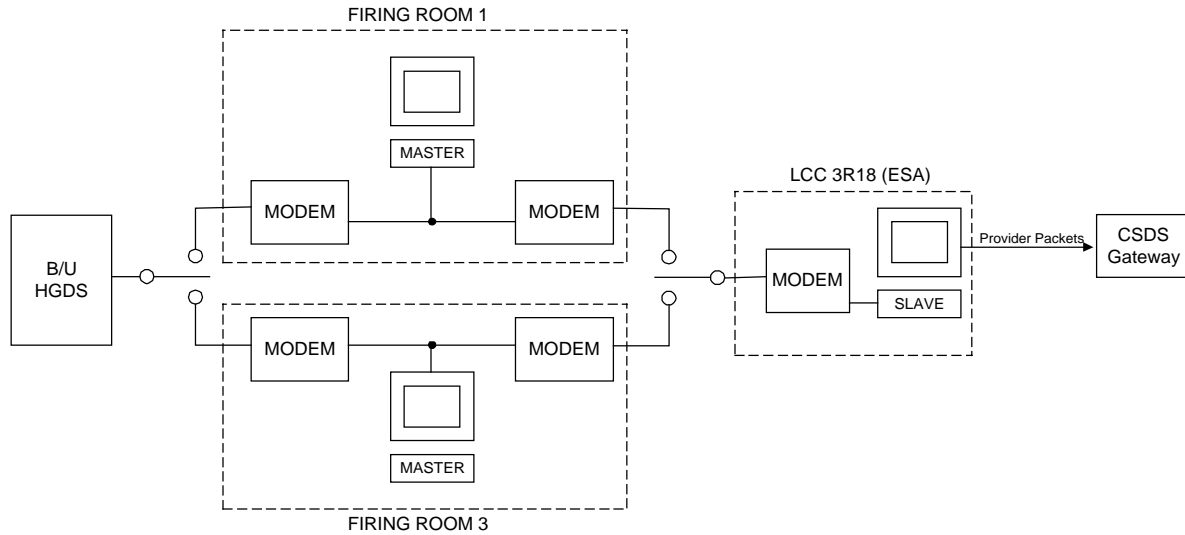
1.4.3 IVHM/HTD Hardware Diagram

LCC (2P10)

LCC (2R24)

LCC-X

CSDS
Gateway

SDS'

HTD Merge
Packets

RTCN

CCP

Command & Control
Processor

DCN

CCWS

Command &
Control
Workstation

Display

SDC

Shuttle
Data
Center

G/W

CS
Gateway

CCWS

Command &
Control
Workstation

Display

DDP

Data Distribution
Processor

HTD

(installed in the
orbiter)

T-0
interface

CCWS

Command &
Control
Workstation

Display

Ethernet
Interface

HTD 1
Command W/S

· Telnet Session
· FTP

·Only used for HTD 1
·Provided by HTD Project

SDS'

DRP
Data Recording
Port

RTCN - Realtime Critical Network
DCN - Display and Control Network

Retrieval
(PcDap/ADAT)

Data Files to User

SODN

SDC

Shuttle
Data
Center

Figure 0-3 CLCS and IVHM/HTD Block Diagram

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

5

1.4.4   RPS Hardware Diagram
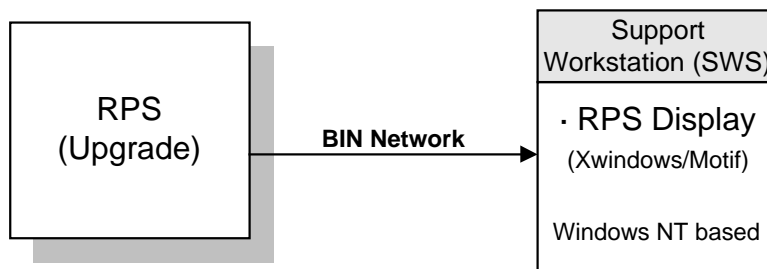
1.4.5   Neural Net Prototype Hardware Diagram
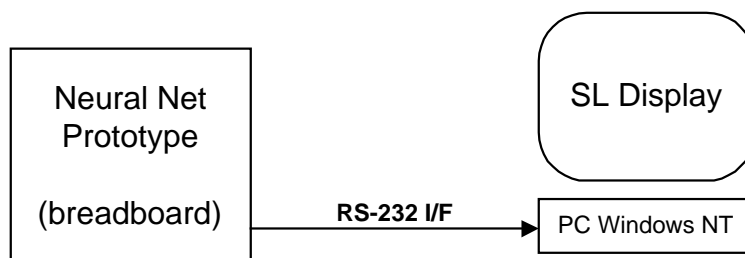
Note: All hardware provided by Shuttle Upgrades Project

1.5   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Deliverables

Deliverable	Document	Code	API Manual	Users Guide
User Application	Yes	Yes		Yes
CS Gateway Services	Yes	Yes		Yes
Test Build and Control				
GMS/Metro	Yes	Yes		
Hazardous Gas	Yes	Yes		
Neural Net Prototype • SL Display	Yes	Yes		Yes
HTD • PCGOAL Display(s) built by HTD (not part of CLCS project)				
Hazardous Gas • PCGOAL Display(s) built by BUHG (not part of CLCS project)				

The following capabilities are provided by this Thread:

- HTD 2
    1. Demonstrate capability to process additional FDs for HTD 2
    2. Demonstrate capability to command HTD 2
    3. Operational support for HTD 2 (3/99)

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

6

- GMS/Metro
    1. Demonstrate capability to receive and process GMS/Metro in CLCS

- Backup Hazardous Gas
    1. Demonstrate capability to merge data into the SDS'
    2. Demonstrate capability to display monitor data in CLCS (FD viewers)
    3. Demonstrate capability to display data in PCGOAL

- RPS
    1. Demonstrate capability to view RPS data via an X-window session in CLCS

1.6   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Assessment Summary

1.6.1   Labor Assessments

The total Labor Costs required to provide this capability are summarized in the following table:

No.	CSCI/HWCI Name	Atlas LM	Changes covered in

1	User Application Software
	   • HTD 2 Monitor Display(s)
	   • HTD 2 Command Displays
		4.0	

2	User Application Software • Neural Net Display	2.0	

3	CS Gateway Services
	   • HTD 2
	   • GMS and Metro
	   • BUHG
		7.0	

4	CSDS Gateway Services (BUHG)	2.0	
5	FD Viewers (BUHG)	0.5	
6	Data Retrieval (PcDap and/or ADAT)	0.0	Data Support Tools Thread
7	TCID Build and Control	0.0	Test Build
8	RPS	0.5	
9	SE&I	3.0	
10	I&T	1.0	
	TOTAL	20.0 LM	

1.6.2   Hardware Costs

None

1.6.3   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Procurement

None

1.7   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Schedule & Dependencies

1.7.1   Schedule

Task Name	Start	Finish

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

7

Task Name	Start	Finish
Atlas Assessment Kickoff		01/20/98
Concept Panel Internal Review		02/24/98
Concept Panel		02/26/98
Atlas Development		
Requirement Panel Internal Review		03/31/98
Requirement Panel		04/02/98
Design Panel Internal Review		05/12/98
Design Panel		05/14/98
CSCI Unit Testing Complete		08/07/98
CSCI Development Integration Test	08/10/98	08/14/98
CSCI Formal Integration Test	08/17/98	08/31/98
CLCS/HTD End-to-End test #1	08/27/98	08/31/98
Support System Test	09/01/98	09/30/98
Atlas Development Complete		09/30/98
CLCS/HTD End-to-End test #2	10/01/98	10/09/98
HTD 2 flight box delivered to OPF		TBD

1.7.2   Dependencies

This section lists dependencies that the thread has in order to be satisfactorily specified, designed, implemented, or tested.

No.	Dependency Area	Dependency	Need Date
1	COTS H/W	CS Gateway	06/01/98
2	HTD	FD information	07/01/98
3	TCID	TCID Build	08/01/98
4	Display S/W	PCGOAL Display (Backup Hazardous Gas)	08/14/98
5	SDC	SDC testing support (recording)	08/17/98
6	HTD	HTD available for testing	8/27/98 - 8/31/98
7	HTD	HTD available for testing	10/01/98 - 10/09/98
8	SDC	SDC Operational support	10/98
9	LCC-X	LCC-X Operational support	10/98

1.8   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Simulation Requirements

During the CS Gateway CIT, the portable CSDS Gateway will be used to verify the interface.

1.9   IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Integration and System Test

1.9.1   IVHM/HTD Testing

Note: All Orbiter power up test operations conducted from LCC 2R24 or LCC X.

Tests to be completed **prior** to HTD installation in the orbiter.

• All circuit tests

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

8

- EDL to LCC 2R24
- OPF2 to LCC 2R24
- MLP1 to LCC 2R24

- Software interface tests
  - HTD Downlink to CS Gateway
  - CS Gateway to CSDS Gateway (HTD merge packets)
  - CS Gateway to SDC via Data Recording Port (DRP)

- Functional
  - HTD Downlink to CCWS displays
  - HTD Downlink to PCGOAL displays
  - HTD Downlink dump to/retrieval from SDC (CLCS)
  - HTD Downlink dump to/retrieval from CDS (CCMS)

Tests to be completed **Following** HTD installation in the orbiter.

- Hardware to Software interface test
  - Channelization of HTD to CCWS displays

- Software interface tests
  - HTD Uplink from CLCS EIM
  - HTD S/W Load and Initialize from CLCS Gateway utility W/S

- End - To - End
  - Integrated Verification Test - OPF2 , OMI_____
  - CountDown Demonstration Test - PADB , OMI S0017

- Mission Support
  - Launch Countdown , OMI S0007

This section is expected to be developed by the Integration and Test representative on the assessment team.

1.9.2   Backup Hazardous Gas Testing

- Circuit test
  - BUHG to CSDS Gateway
  - CSDS Gateway to CS Gateway

- Software interface tests
  - BUHG to CS Gateway
  - CSDS Gateway to CS Gateway
  - CS Gateway to SDC via DRP

- Functional
  - BUHG to CCWS displays
  - BUHG to PCGOAL displays
  - BUHG dump to/retrieval from SDC (CLCS data)
  - BUHG dump to/retrieval from CDS (CCMS data)

1.9.3   GMS and Metro Testing

- Circuit test
  - CSDS Gateway to CS Gateway

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

9

- Software interface tests
  - CSDS Gateway to CS Gateway

- Functional
  - GMS data to CCWS displays via CS Gateway
  - GMS/Metro Data dump to/retrieval from SDC (CLCS data)

1.9.4 RPS

The test will verify that the X-window can be brought up on the Support Workstation (SWS).

1.10 IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Training Requirements

None

1.11 IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Facilities Requirements

LCC-X is assumed to be a dedicated resource while supporting HTD 1 launch operations during the STS-95 (10/98) and HTD 2 launch operations during the STS-97 (3/99)

1.12 Travel Requirements

None

1.13 IVHM/HTD, RPS, Backup Hazardous Gas and other consolidated data Thread Action Items/Resolution

This section contains a list of open Action Items to be worked. On subsequent panels, the resolutions should be stated.

2. CSCI Assessments

This section is provided for the individual CSCI leads to fill in and provide the details of their assessments. The lead should use this information to provide the summaries in section 1. The details are not presented in any of the panels unless needed by the presenter as backup.

2.1 Consolidated Systems Services CSCI Assessment for IVHM/HTD

CS Receive HTD 2 Data CSC Work Required

. Reformat floating point number to IEEE single precision float number
. Reformat received packets to smaller size for transport over UDP to the CSDS Gateway

CSC Name	CSC Labor (LM)	% of CSC
CS Receive HTD 2 Data	2	15

Basis of estimate

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

10

CS Receive HTD 2 Data CSC is estimated to be approximately 500 lines of code (LOC). This estimated builds upon/modifies the code written for HTD 1.

Documentation

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	Update	5
Users Guide	NA	
API Interface Document	NA	
Interface Design Document	NA	
Test Procedure	Update	10

Assumptions

None

Open Issues

None

2.2   Consolidated Systems Services CSCI Assessment for GMS and Metro

CS Receive GMS & Metro Data CSC Work Required

. Initialize Network UDP Communication
. Decommutate GMS data packet
. Decommutate Metro data packet

CSC Name	CSC Labor (LM)	% of CSC
CS Receive GMS & Metro Data	2	15

Basis of estimate

CS Receive GMS & Metro Data CSC is estimated to be approximately 1000 lines of code (LOC). 80% of this estimated LOC is reused from the CSDS Gateway code.

Documentation

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	Update	5
Users Guide	NA	
API Interface Document	NA	
Interface Design Document	NA	
Test Procedure	Update	10

Assumptions

None

Open Issues

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

14

None

2.3 Consolidated Systems Services CSCI Assessment for Backup Hazardous Gas Detection System

A new CSC will be developed to process Backup Hazardous Gas Detection System Data received from the Consolidated Shuttle Data Stream Gateway.

Consolidated Systems Backup Hazardous Gas Processing CSC Work Required

Software will be developed for the Consolidated Systems Services CSCI that resides on the Consolidated Systems Gateway. Back-up Hazardous Gas Data will be received from the Consolidated Shuttle Data Stream Gateway in the form of PCGOAL merge packets, Data will be extracted from the packet and assigned an FD and inserted into the CS Gateway Change Data Stream.

CSCI Assessment

CSC Name	CSC Labor (LM)	% of CSC
Consolidated Systems Backup Hazardous Gas Processing CSC	3	100

Basis of estimate

The processing requirements for this CSC are similar to the GMS processing in the Consolidated Shuttle Data Stream Gateway.

Documentation

Provide your assessment of the kinds and amount of documentation that must be provided with the capability.

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	New	
Users Guide	Update	
API Interface Document	N/A	
Interface Design Document	New	
Test Procedure	New	

Assumptions

None

Open Issues

None

2.4 Consolidated Shuttle Data Stream Services CSCI Assessment for Backup Hazardous Gas Detection System

A new CSC will be developed to process Backup Hazardous Gas Detection System Data received from the BUHG.

Consolidated Systems Backup Hazardous Gas Processing CSC Work Required

Software will be developed for the Consolidated Shuttle Data Stream Services Services CSCI that resides on the Consolidated SDS Gateway.   Back-up Hazardous Gas Data will be received from the BUHG system in the form of PCGOAL merge packets, Data will be extracted from the packet and assigned an FD and inserted into the SDS' Data Stream.

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

12

CSCI Assessment

CSC Name	CSC Labor (LM)	% of CSC
Consolidated Systems Backup Hazardous Gas Processing CSC	2	100

Basis of estimate

The processing requirements for this CSC are similar to the GMS processing in the Consolidated Shuttle Data Stream Gateway.

Documentation

Provide your assessment of the kinds and amount of documentation that must be provided with the capability.

Example:

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	New	
Users Guide	Update	
API Interface Document	N/A	
Interface Design Document	New	
Test Procedure	New	

Assumptions

None

Open Issues

None

2.5 HTD 2 Displays CSCI Assessment

This CSCI is part of the Real-Time Control Application Software. For the IVHM HTD2, two new monitor displays and one new command display will be developed. In addition, the displays previously built for HTD1 will also be used.

CSCI Assessment

CSC Name	CSC Labor (LM)	% of CSC
Monitor displays (2)	2	66
Command display (1)	2	34
Total	4	100

Basis of estimate

This assessment is based on the assumption of requiring only three new displays to be built - two for monitoring and one for commanding. Each monitor display will take approximately one labor month to complete. The command display will take approximately two labor months due to the learning curve for connecting displays to commands.

Documentation

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

13

None.

Assumptions

- Displays previously built for HTD1 will be used for HTD2.
- Displays for HTD2 will monitor only a subset of the total HTD2 measurements.
- Three new displays will be built for HTD2:
  - Two new displays for monitoring measurements.
  - One new display with commanding capability.
- Commanding capability will be limited to the six command Function Designators which had been proposed for HTD1.
- Displays can be created using SL-GMS (no other tools are required).
- No formal certification or documentation is required.

Open Issues

None.

2.6   Neural Net Display Assessment

A new display will be developed to receive and display Neural Net prototype data. The displays will run on a Windows NT machine.

CSCI Assessment

CSC Name	CSC Labor (LM)	% of CSC
Monitor display	2	100

3.   HWCI Assessments

This section is provided for the individual HWCI leads to fill in and provide the details of their assessments. The lead should use this information to provide the summaries in section 1. The details are not presented in any of the panels unless needed by the presenter as backup.

3.1   HWCI Assessment

None.

4.   COTS Products Dependencies

4.1   SW Products Dependency List

None

4.2   HW Products Dependency List

Product Name	Quantity Needed	Need Date

Printed documents may be obsolete. Check the CLCS Documentation Baseline web pages for current approved revision of this document before using it for work

14

Product Name	Quantity Needed	Need Date